

## **Marsh Creation From Dredged Material - A Case Study**

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The Interagency Coordination Team (the ICT) established by the U.S. Army Corps of Engineers (USACE), was charged with oversight of a range of environmental issues attendant upon the proposed Houston-Galveston Navigation Channels, Texas Project (HGNC Project). The Beneficial Uses Group (the BUG) was created in early 1990 as a subcommittee of the ICT with the assigned task to evaluate possible beneficial uses of dredged material and incorporate them into a dredged materials placement plan for the HGNC Project. The BUG's membership includes 5 federal agencies: [U.S. Fish and Wildlife Service (USFWS), U.S. Environmental Protection Agency (EPA); USACE; Natural Resources Conservation Service (NRCS); and National Marine Fisheries Service (NMFS)]; 2 state agencies: [Texas Parks and Wildlife Department (TPWD); and Texas General Land Office (TGLO)]; and the Port of Houston Authority (PHA).

The Houston Ship Channel (HSC) Modernization Project and the Recommended Beneficial Uses Disposal Plan (the BUG Plan) for the bay reach of the HSC will entail removal and disposal of approximately 92 million cubic yards of dredged material over the 50-year life of the project. The dredged material placement plan for the HGNC Project includes construction of 4,250 acres of intertidal wetlands, a 12 acre bird nesting island, and 320 acres of shoreline protection.

In August 1992, shoaling within the Bayport Ship Channel Flare (the intersection of the Houston and Bayport ship channels), created a navigational impediment to vessels transiting the Bayport Channel to and from the Houston Ship Channel (HSC). The need to dredge the channel flare to the authorized project depth of -40 feet (ft) Mean Low Tide (MLT) created an opportunity for the PHA, the USACE, and the BUG to construct a Demonstration Marsh using equipment and materials similar to those anticipated for the proposed widening and deepening construction of the HSC. The purpose of the Demonstration Marsh is to identify key environmental and design parameters and management requirements needed for the establishment, growth and survival of created marsh. These requirements include identification of the key operating requirements for the typical dredging equipment most likely to be utilized for the future placement of maintenance dredging material for beneficial uses from the HSC. The 220-acre Demonstration Marsh project is located in upper Galveston Bay within the limits of the existing HSC disposal areas known as Cells 15 and 16, and includes approximately 180 acres of intertidal salt marsh and 40 acres of shallow open water.

The essential elements of the marsh design for construction were: 1) construction of a hydraulically-placed containment levee using suitable materials such as stiff clays, sand and shell; 2) placement of fill material for marsh substrate typically using fine-grained materials associated with maintenance dredging; and 3) construction of levee protection measures to prevent erosion and protect the marsh interior.

Dredged material contaminant testing was performed to determine any potential environmental impact from the disposal of maintenance material from the Bayport Channel and HSC maintenance material, and to evaluate the potential for beneficial uses of the maintenance material. The sampling plan was designed to comply with Section 404(b) of the Clean Water Act, as amended; Public Law 92-500, and in accordance with The EPA/USACE "Green Book" (EPA 1991). The testing performed consisted of chemical analyses, suspended particulate phase (SPP) bioassays, solid phase (SP) bioassays, and bioaccumulation studies. Results of dredged material testing indicated no cause for concern for beneficial uses of the material.

Bioengineering studies by the NMFS to determine the physical characteristics of functioning, natural marshes were conducted. These studies were used as references for the Demonstration Marsh to determine the open water to marsh ratios, length, width and depth of intertidal channels in addition to the elevation of the substrate required to establish and sustain a variety of marsh vegetation.

Considerable design work was carried out prior to construction of the site. Detailed hydrographic surveys of the HSC borrow and fill areas were performed and geotechnical investigations entailing eighteen soil borings spaced at 1,000-foot intervals along the channel borrow area, thirty-five probings of the sub-bottom foundation along the proposed levee alignment, along with seven undisturbed samples to analyze bay bottom foundation characteristics were completed. Six drop cores of the maintenance dredging material were obtained to determine the shrinkage and consolidation characteristics using lab test results and the USACE's Primary Consolidation and Desiccation of Dredged Fill (PCDDF) computer model. This model predicts settlement and consolidation of dredged material based on the type of material and other factors. Calibration of this model using data obtained from the Demonstration Marsh will enhance the future design of marsh sites, in particular designating the elevation for dredged material to be pumped into the site so that after drying, settlement, and consolidation, the dredged material is at an elevation suitable for marsh establishment. Based upon the results of the geotechnical investigations, a levee alignment was developed that would provide adequate disposal capacity for maintenance material quantities and allow the fill material to settle and consolidate to an elevation suitable for marsh establishment.

A 6,800 LF hydraulic fill levee was constructed using a 30 inch hydraulic cutterhead dredge to remove new work clays and sands from a borrow area in the Houston Ship Channel. Two spillboxes were placed within the levee to decant the fill material and to direct the flow of fill material during dredging operations. Through strategic placement of the spillboxes, thus controlling of the direction of fill movement, marsh features such as ponds and coves may be constructed by limiting the quantity of material that will flow to areas within the containment levee such as the corners of the levee and the area between the spillboxes. As a result of this management, two ponds were constructed on the north and south ends of the Demonstration Marsh site after fill placement. Following levee construction the site was filled to an approximate elevation of +6.56 ft MLT with 1,598,899 yd<sup>3</sup> of maintenance material obtained from the Bayport Channel Flare.

To identify possible cost-effective alternatives for levee protection for the beneficial uses sites when compared with the use of stone rip-rap, selected erosion protection measures were installed, including: 1) vegetation, 2) Geoweb, 3) Geotubes, and 4) Pyramat. Although stress related tears in the surface of the tubes have required continuous repair, the Geotubes continue to provide the most promising shoreline protection alternative to rip-rap. In addition, a vigorous fringe marsh has been established along the lower slope of the levee and is providing erosion protection as well as fringe marsh habitat on the lowest energy section of the levee.

After construction of the Demonstration Marsh, management of the dredged material was undertaken to achieve the target fill elevation of +2.11 ft to +2.66 ft MLT. Initial filling and dewatering of the site resulted in a level fill surface required to achieve the microtidal environment typical of Galveston Bay marshes. Geotechnical investigations used to estimate the fill settlement were refined during the settling period and will be utilized to predict settling rates for future beneficial uses sites. Construction of an internal drainage ditch was required to assist in the consolidation phase of the site, and the target fill elevation was reached in March 1995, 675 days after filling was completed. Bioengineering parameters for the Demonstration Marsh were patterned after naturally occurring attributes at reference marshes near the site. Two large ponds, which remained after filling the Demonstration Marsh, were incorporated into the site design. Channels and small ponds will be added to the site after plant establishment to create "edge" and improve productivity at the site.

A planting plan for the interior of the marsh was developed using plant species similar to those found in reference marshes. The Demonstration Marsh was divided into 66 test plots [1.01 acre each plot] developed to evaluate the statistical differences between various *Spartina alterniflora* planting treatments and propagule types. In September, 1994, the Port of Houston Authority and the Natural Resources Conservation Service (NRCS) entered into a Cooperative Agreement with the following purposes and objectives: (1) To assess the effectiveness of different nursery techniques in producing marsh plants, (2) To assess the relative effectiveness of marsh planting by varying plant densities (i.e., survival rates and percent aerial coverage over time.), (3) To compare the success of the Demonstration Marsh planting plan in relation to the parameters derived by the National Marine Fisheries Service (NMFS) from the reference marshes for plant coverage and density, and (4) To develop baseline data on the major cost elements of marsh planting to provide a closer identification of actual costs for evaluation of competing proposals for future marsh construction associated with the Beneficial Uses Plan. The NRCS utilized personnel from the Americorp Project, a civil works program implemented in 1993 to provide job experiences for young adults, to plant the Demonstration Marsh. The NRCS provided supervision and technical assistance in cooperation with the BUG during planting of the Demonstration Marsh. The planting of the Demonstration Marsh began in February 1995 and was completed in July 1995.

The Monitoring and Management (M&M) Plan developed for the BUG Plan provided only a framework to guide monitoring and management, therefore, methodologies are being developed for the Demonstration Marsh to provide data useful in determining the level of ecological function at the site when compared to natural marshes. These methodologies will be modified as needed to

provide functional tools for monitoring the future BUG sites. Following the M&M Plan framework developed for the BUG Plan, routine and comprehensive assessments are being used to monitor the Demonstration Marsh.

Routine Assessments allow for early detection of potential problems and monitor development of the site and typically include photodocumentation of site features, observations of plant health and observations of avian utilization. Avian monitoring is being performed to determine the variability and density of birds associated with various habitat types found on the marsh; seasonal variability and density within the marsh; and nesting and fledging success in different habitat types. Least terns have established nesting colonies on the levee for three nesting seasons (1993-1995). Black skimmers have also utilized the levee and the sand beach as nesting habitat. The marsh has become a popular site for many wading birds including roseate spoonbills, great egrets, reddish egrets, wood storks, white-faced ibis and others. Mud flats provide rich feeding areas for many of the sandpipers, willets, semipalmated plovers, and others. Since the site was created, over 100 species of birds have been sighted utilizing the Demonstration Marsh.

Comprehensive Assessments generate more complete and quantitative information on the performance of various aspects of the Demonstration Marsh. The planting plan is being monitored on a semi-annual basis to determine growth and cover of the planted *Spartina alterniflora*. Digital infrared images are being used to monitor and evaluate vegetation characteristics on a time sequence basis. Three aerial photographs were taken on August 17, 1995, November 12, 1995, and April 10, 1996. The fourth will be taken in October 1996. These photographs are being used with digital vector information describing the position of all 66 one-acre plots. For each set of data *S. alterniflora* percent cover are being determined within each plot and for the whole marsh, using infrared image analysis. Plant cover estimates are being compared between propagule types and planting spacings. Data collected from the Demonstration Marsh will be used to determine plant spacing and propagule types to be used in planting the BUG Plan marshes.

Lessons learned from the Demonstration Marsh will be used to enhance the potential success of the construction of the Restoration Plan for the Houston Ship Channel Authorization Project recently authorized by Congress. Monitoring and management of the constructed sites will play an important role in their future success.